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TECHNICAL INFORMATION
REPORT 8-1-3A24(2)

OFFICE, CHIEF OF ORDNANCE
FEBRUARY 1960

DEVELOPMENT

OF

POINT-DETONATING FUZE, M524 (T186E11)

*PREPARED FOR THE U. S. ARMY MATERIEL COMMAND BY THE ARMY MATERIEL RESEARCH STAFF, UNIVERSITY OF PITTSBURGH, UNDER CONTRACT DA-36-034-AMC-3785(X)".

Point-detonating (PD) fuzes of the T186 series were designed for selective superquick or delay (SQ/D) impact functioning with improved high-explosive (HE) and chemical shell for 81- and 105-mm mortars. Although work on 105-mm mortar ammunition has been suspended, development of the T186 series of mortar fuzes was continued for 81-mm rounds. When its development was authorized in August 1946, the T186 was to be a dual-purpose, mechanical fuze that would not only be more sensitive than the M52 series of SQ fuzes for the then standard 81-mm mortar rounds, but would also have a delayed functioning of 0.15 second, if desired, and would function upon graze impact. The fuze has been modified a number of times, and its characteristics as well as details of its construction have also changed. By 1951, the desired delayed-functioning time had decreased to 0.05 second. The T186E11 model, which was submitted to US Continental Army Command (USCONARC) boards for user tests, provides selective SQ and 0.05-second-delay functioning on impact with average terrain at any angle from 15 to 90 degrees from a line tangent to the trajectory at the point of impact. This fuze also has an arming delay of 1.75 $\pm$0.50 seconds after the round has left the tube at any permissible charge and elevation for 81-mm mortars. It is supplied with a pull wire for safety in storage, transportation, and aerial delivery. It is operable after delivery by a properly functioning parachute and is safe for disposal after delivery by a malfunctioning parachute. Although it is not moistureproof, it is more resistant to moisture than either the M52 series or M519 mortar fuzes that it will replace, or the propellent charge of the cartridges for which it was developed.

During the early period of the development of the T186 series of PD fuzes, it was difficult to obtain models that functioned satisfactorily. This problem led to the development in 1953 of the T312 and T313 SQ fuzes as interim items for the 81- and 105-mm shell, respec-

RELATED TIR'S

10-59	TIR 6-7-7A1(4)	81-mm HE Shell, T28 Series
7-58	TIR 6-7-8A1(1)	81-mm Chemical Shell, M370 (T30E9)
3-57	TIR 8-1-3	Development of Point-Detonating Fuzes for Artillery and Mortars
8-59	TIR 8-1-3A25(1)	PD Fuze, T312
8-59	TIR 8-1-3A26(1)	PD Fuze, T313

tively, in order not to delay testing of the improved mortar shell for which the T186 was designed. Later in 1953, work on another intermediate fuze, the T319, was started. This fuze was classified standard as the M519 in 1955, and quantities of them have been produced and placed in Field Service stocks, assembled to the M362 (T28E6) 81-mm HE shell.

In late 1953 a small number of T186E9 fuzes were tested at Aberdeen Proving Ground (APG), where they functioned satisfactorily at ambient temperature. It was, therefore, planned to conduct engineering and service tests of this model during 1954. When the T186E9 fuzes, assembled in T28-series 81-mm HE shell, were tested at temperature extremes of 40 degrees below zero and 160 degrees above zero Fahrenheit at APG in February 1954, however, approximately 20 per cent failed to function satisfactorily. Although this high dud rate was reduced to about 9 per cent in additional tests during May 1954, it was apparent that further modification of the fuze was required, and fabrication of the T186E10 was accordingly begun.

Final engineering tests of the T186E10 were started at APG in mid-September 1954, but because of unsatisfactory performance, the tests were stopped at the end of the month. The fuze was again modified in 1954 to become the T186E11; the principal changes were made in the timing device, the plunger, and the creep pin that restrained the plunger during the projectile's flight.

A few hundred T186E11 fuzes were fabricated by a contractor and tested at APG during February and March 1955. These tests were thoroughly successful, and more than 99 per cent of the fuzes functioned satisfactorily at temperatures of 65 degrees below zero and 70 degrees and 160 degrees above zero Fahrenheit. On the basis of these tests, several thousand T186E11 fuzes were prepared for engineering evaluation tests with 81- and 105-mm shell. This larger quantity was assembled by Picatinny Arsenal by salvaging excess parts of the T186E8 fuzes, which had a dud rate of about 8 per cent when tested earlier at APG. The modified fuzes contained some parts, the design of which had been superseded (such as the gear train), and other parts that did not meet close tolerance specifications. When these fuzes were tested at Fort Churchill, Canada, they did not perform as well as the lot of T186E11, made by the contractor to close tolerances, tested at APG. At Fort Churchill, however, 96.3 per cent of these fuzes functioned satisfactorily, thus comparing favorably with the M52A2 PD mortar fuzes, which had a dud rate of 3.8 per cent.

Although final engineering tests were not completed until August 1957, T186E11 (modified T186E8) fuzes had been supplied to CONARC for service tests prior to that time. During the winter of 1955-1956 tests were conducted on these fuzes at ambient temperatures of from 20 degrees below zero to 47 degrees below zero Fahrenheit by CONARC's Arctic Test Branch (ATB). These tests were carried out with T186E11 fuzes assembled to T53E2 HE and T54E1 105-mm white-phosphorus (WP) shell and to M362 HE and T30E9 WP 81-mm shell. Men wearing arctic mittens could not remove the pull wire from the fuze, and those wearing the M1951 trigger finger mittens found it difficult to remove the pull wire. In most instances, they had to use bare hands to remove

it, and occasionally they used pliers. The dud rate of the rounds tested, attributable to malfunctioning of the fuzes, was 3.8 per cent. In separate reports, covering the cartridges tested with the T186E11 fuze, ATB recommended in June 1956 that the fuze be modified to remove the deficiencies noted. In September 1956 CONARC Board Number 3 (now the US Army Infantry Board), on the basis of its tests and a review of ATB tests, indicated that it would not object to the adoption of the T186E11 fuze as standard if the deficiencies were corrected. This suggestion was approved by CONARC in January 1957 and finally by the Chief of Research and Development, Office, Chief of Staff, who so informed the Office, Chief of Ordnance.

In January 1957 in a report on the T186E11, ATB recommended type classification of the fuze. A similar recommendation was made by the US Army Infantry Board in November 1957 and approved by CONARC in December 1957 and by the Chief of Research and Development in May 1958. The T186E11 was made standard A as the M524 in May 1958.

Meanwhile, the T186E11 fuze had been released for a production engineering study in August 1956, and in February 1957 it was released for production, or production engineering, as required. The production engineering model has been designated the T186E12, which is similar to the T186E11 but will cost less to make. Picatinny Arsenal has designed a new pull wire that will be incorporated in the T186E12. The redesigned pull wire can be removed by untrained troops wearing arctic mittens in 2.2 seconds, compared with the 5.0 seconds required to remove the pull wire of the T186E11. A production order for a quantity of the T186E12 fuzes was placed in August 1958. It is expected that these fuzes will be available early in 1960 and that some of them will be shipped to the interested USCONARC test boards for check tests.

The M524 combines a striker containing two firing pins, a plunger containing separate explosive elements for SQ and delay action, and an arming-delay mechanism actuated by setback force. The fuze comprises the following parts and assemblies:

1. A spring-supported striker fitted with separate SQ and delay firing pins and adjustable for either SQ or delay functioning

2. A body, adapted to contain the striker, a detent, a plunger, and an arming mechanism

3. A detent that engages the striker to restrain the striker in the SQ or delay position

4. A plunger that contains an SQ detonator and lead charge and a 0.05-second-delay element

5. An arming-mechanism assembly containing a spring-driven rotor mounting an out-of-line detonator, a setback device to lock the rotor in the unarmed position until the round is fired, a timing device to delay the arming of the rotor for 1.75 $\pm$0.50 seconds after setback ceases, a creep

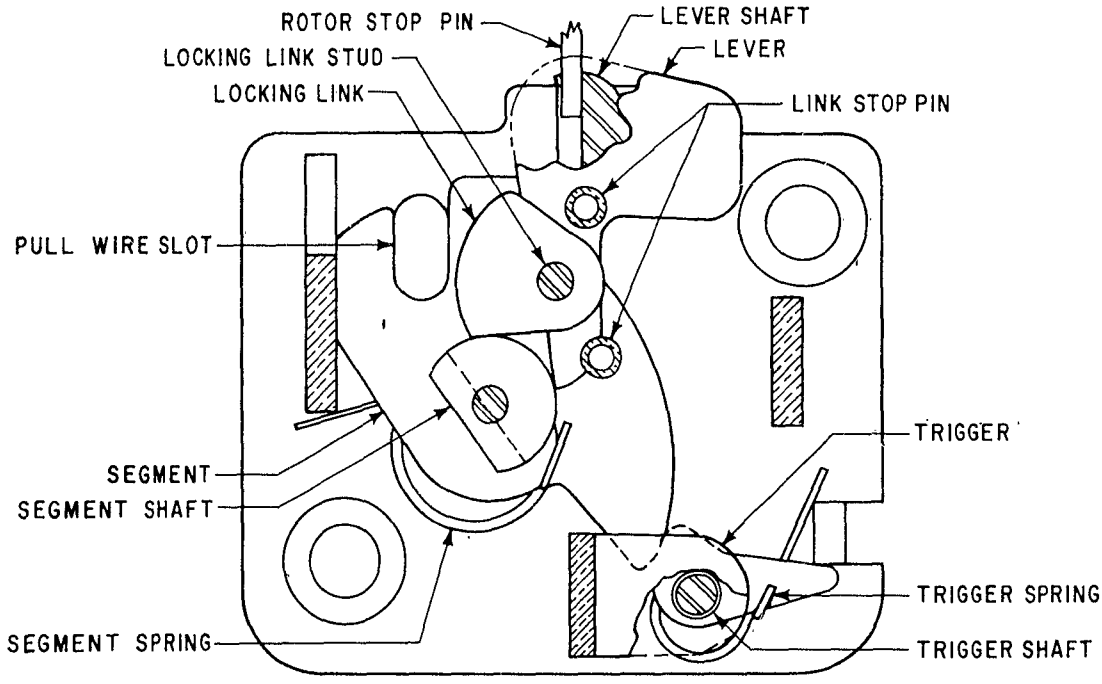
pin and spring to restrain the plunger during flight, and an RDX booster lead

6. A booster assembly containing a tetryl pellet in a cup

7. A pull wire inserted in the setback device to provide safety in transportation, handling, and aerial delivery

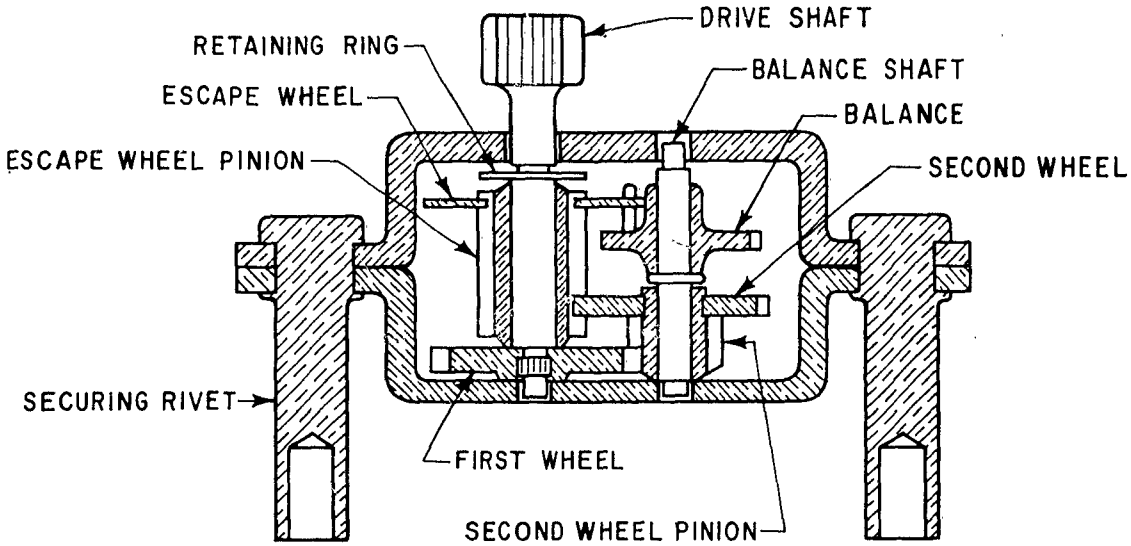
The M524 is assembled, stored, and transported in the unarmed condition. It is set at SQ, with the end of the pull wire inserted near the base of the fuze and extending through a slot in the setback device to maintain the segment in the safe position and prevent accidental arming. The pull wire is removed before the round is inserted in the mortar tube and, if delayed action is desired, the striker is manually rotated to align the slot with the "D" index on the body. The fuze does not become armed until the round is fired and the shell leaves the muzzle of the tube, unless the round, with the pull wire removed, is accidentally dropped from a height of more than 6 feet. Any round so dropped may be armed and should be disposed of with proper precaution.

Arming action begins when setback causes the trigger and the segment of the setback device to rotate clockwise. The segment of



CROSS SECTION OF SETBACK DEVICE OF PD FUZE, M524 (T186E11)

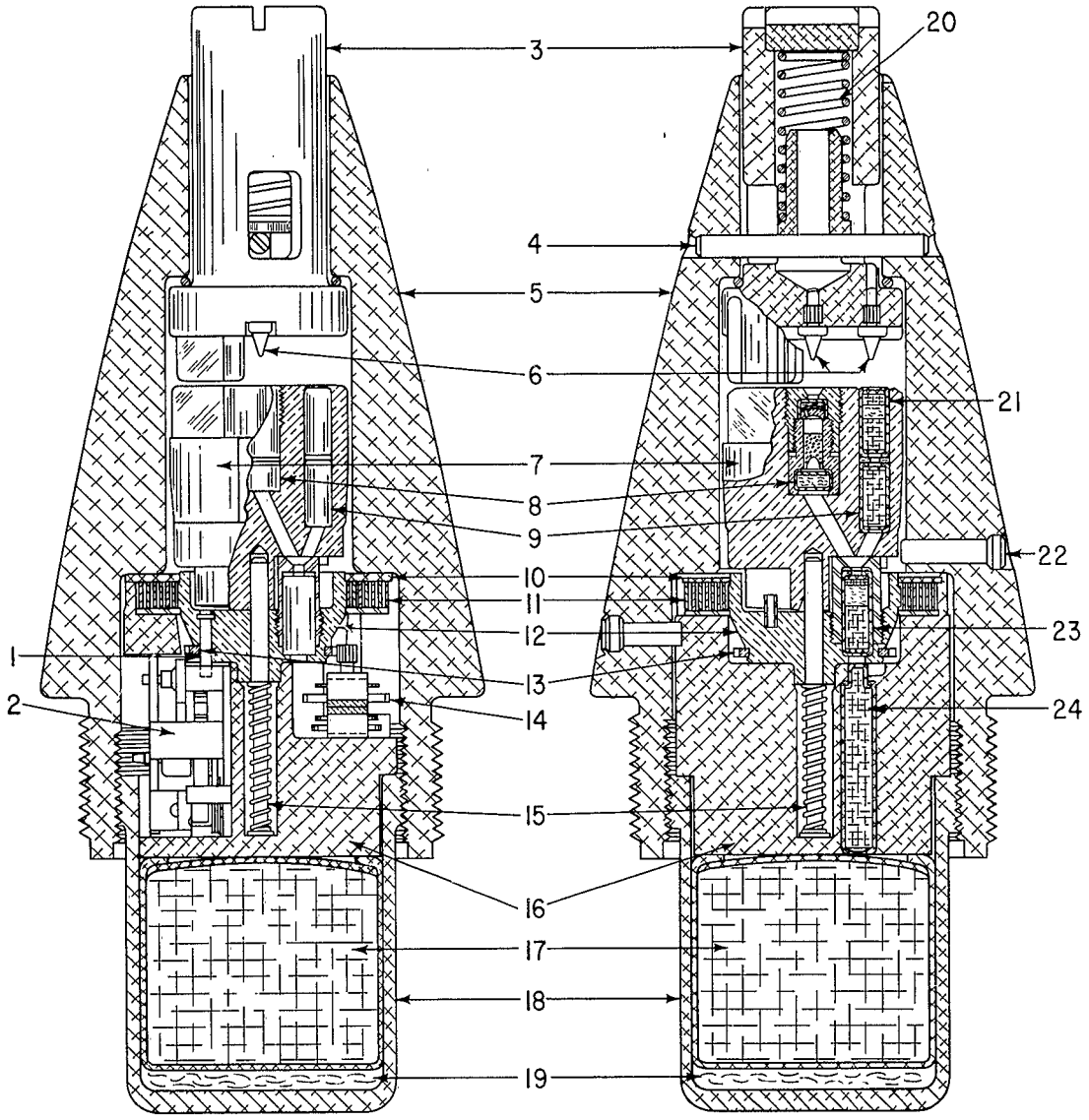
the setback device is then turned clockwise approximately 130 degrees by the forces acting on it. The segment shaft is then in the armed position and is locked there by the counterclockwise rotation of the locking link, which prevents the segment from returning to the unarmed position. The flat section of the segment shaft permits the lever of the setback device and its shaft to rotate clockwise. During acceleration of the round in the mortar tube, the friction between the rotor and the body of the arming mechanism produced by the setback force prevents any movement of the rotor. After the shell leaves the muzzle, the force exerted by the rotor stop pin on the flat of the lever shaft rotates the lever assembly clockwise until the pin is disengaged from the setback device. The rotor is then driven by its spring to the armed position. The plunger, which is keyed to the rotor, rotates clockwise with it to the armed position.



CROSS SECTION OF TIMING DEVICE OF PD FUZE, M524 (T186E11)

The rotor and plunger move through an angle of 260 degrees from the armed position. During approximately 200 degrees of this rotation, the timing gear of the rotor meshes with the drive shaft of the timing device. The gear train of the timing device is driven by the rotor, but by means of the balance and escape wheel, the timing devices delay the movement of the rotor and plunger to the armed position for a period of 1.75 ±0.50 seconds. The rotor and plunger move unopposed through the final 60 degrees of rotation to the armed position.

In the armed position, the base of the M22 detonator in the rotor is aligned with the booster lead charge in the body of the arming mechanism; the head of the detonator remains aligned with the flash



CROSS SECTION OF PD FUZE, M524 (T186E11), WITH PULL WIRE REMOVED AND SET FOR SUPERQUICK ACTION

1. Rotor Stop Pin
2. Setback Device
3. Striker
4. Striker Guide Pin
5. Fuze Body
6. Firing Pins
7. Plunger
8. M2 Delay Element
9. Plunger-Lead Assembly
10. Retaining Plate
11. Drive Spring
12. Rotor
13. Timing Gear
14. Timing Device
15. Creep Pin and Spring
16. Arming-Mechanism Body
17. Booster
18. Booster Cup
19. Felt Pad
20. Striker Spring
21. T33E1 Detonator
22. Safety Pin
23. M22 Detonator
24. Booster-Lead Assembly

path from both the SQ and delay elements in the plunger. If the fuze is set for SQ action, at the end of the arming delay period the outer firing pin of the striker is aligned with the T33E1 SQ detonator in the plunger; if set for delayed action, the outer firing pin is aligned with a shallow cavity in the face of the plunger. At either setting (a) the inner firing pin remains aligned with the M2 delay element in the plunger and (b) a lug on the striker, on arming, aligns with a large cavity in the plunger.

The fuze functions on impact when the striker is driven rearward. If the striker slot is set at SQ the firing pins strike both the T33E1 SQ detonator and the M2 delay element to produce SQ action of the explosive train. If the striker slot is set at the D (delay) index, only the M2 delay element is struck, and the explosive train is initiated after a delay of 0.05 second. The flash from the T33E1 SQ detonator and the plunger lead charge or from the M2 delay element is transmitted by the M22 detonator to the RDX booster lead charge in the base of the arming-mechanism assembly. This initiates the tetryl pellet in the booster, and the booster then sets off the explosive in the mortar shell. Should impact occur at an angle at which the striker is not driven rearward, inertial forces move the plunger forward and force the M2 delay element and the T33E1 detonator, or the M2 delay element alone, against the firing pins of the striker to set off the explosive train. Prior to arming, forward movement of the plunger is prevented by the lug on the striker.

Fuzes of the T186 series have successfully passed standard jolt-and-jumble tests; with pull wires attached, they can be safely dropped 40 feet. Drop safety with the pull wires removed is ensured by the requirements for sufficient setback energy to rotate the segment to the armed position and sufficient duration of setback to maintain the trigger in the setback position while the segment is rotating. Following determination of the drop-safety limits of the early models with the pull wires removed, some consideration was given to the feasibility of increasing these limits by modifying the strength of the spring of the setback segment. As this would affect the functioning of the fuze, which is generally satisfactory, the drop-safety requirements have not been changed. With pull wires removed, fuzes of the T186 series are safe when dropped 40 feet onto a steel plate, 15 feet onto a wood plank, 10 feet onto sod or sand, 8 feet onto concrete, and 6 feet onto a hard board supported at each end. If a round is accidentally dropped from a height greater than 6 feet after the pull wire has been removed, however, it should be disposed of on the assumption that the fuze has become armed. Aerial-delivery tests have been completed by Jefferson Proving Ground, and the results show that the M524 fuze is safe to fire if dropped with a correctly functioning parachute and is safe for handling and disposition if dropped with a malfunctioning parachute.

PRINCIPAL CHARACTERISTICS

Model	M524 (T186E11)
Type	selective superquick or delay, point-detonating
Material	
Body	aluminum
Striker	aluminum
Plunger	aluminum
Arming mechanism assembly	aluminum and brass
Booster assembly	aluminum
Weight	1.27 lb
Length, over-all	6.01 in
Length of intrusion	2.21 in
Thread size	2-12 UNS-1A
Method of arming	setback
Time of arming delay	1.75 $\pm$0.50 sec
Method of actuation	impact
Explosive train	
Delay element	M2
SQ detonator	T33E1
Plunger lead	1.9 grains of RDX
Rotor detonator	M22 (T34E1)
Booster lead	8.67 grains of RDX
Booster charge	620 grains of tetryl
Temperature limits	-40° F to 160° F
Cartridges with which fuze is used	
81-mm HE shell	M362 (T28E6), M362A1 (T376)
81-mm chemical shell	M370 (T30E9)
81-mm TP shell	M362